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Strengthening the Performance of Reinforced Concrete Columns using Welded Wire Reinforcement – An Experimental Investigation

Valluru Viharika[1, a *] and Dr. Sunil Kumar Tengali [2,b]
[1] Assistant professor,
[2] Professor
School of Civil Engineering
REVA University,Bengaluru.

ABSTRACT

An experimental investigation was carried out to study the behaviour of normal-strength concrete confined by welded wire reinforcement as transverse reinforcement (WWR). WWR eliminates some of the detailing problems inherent in reinforced concrete (RC) construction, resulting in easier and faster construction, with better economy and quality control. The confinement provided by WWR was investigated by their strength characteristics by conducting test on 16 columns. The specimens were tested under axial loading. The parametric study includes effect of volumetric ratio and spacing of WWR as well as distribution of longitudinal reinforcement. The results indicate that Performance of welded wire reinforced columns with 1% steel has minimum deformation than conventional columns, whereas, with 2% steel has deformation greater than conventional columns. Experimental ultimate load of SW1@200 c/c showed 21% increase over calculated theoretical ultimate load. Experimental young's modulus determined by second order polynomial equation, is lesser than calculated theoretical young's modulus.

Keywords: Compressive Strength, Welded Wire Reinforcement, Ductility, Crack Pattern, Deformation , Elastic Modulus.

1. INTRODUCTION

In the present scenario, many existing structures situated in seismic zone weren't designed adequately as per to seismic design codes. Research has been carried out on various strengthening techniques to enhance the seismic performance of reinforced concrete (RC) structural elements. However, the seismic behavior of the structure may not be improvised by retrofitting or rehabilitation unless the engineer selects an alternative technique based on seismic assessment of the structure. In any structure prominent role is played by columns. Therefore, alternative reinforcing technology should be adopted to overcome the failure of columns in seismic zone.

2. STABILITY OF COLUMNS

A perfectly straight slender column with elastic material properties, when subjected to axial load, passes through three states: stable equilibrium, neutral equilibrium, and instability. If a lateral force, is applied between the two ends of a stable equilibrium column, it produces a small lateral deflection which disappears and the column returns to its straight form. If the column load is gradually increased, a condition is reached in which the straight form of column becomes socalled neutral equilibrium, and a small lateral force will produce a deflection that does not disappear and the column remains in this slightly bent form when the lateral force is removed. The load at which neutral equilibrium of a column is reached is called the critical or buckling load.

3. EXPERIMENTAL PROGRAM:

Properties of concrete in terms of fresh and harden state

Table 3.1.1: Physical properties of cement

Physical properties	**Cement**
Specific gravity	3.1
Initial setting time	30 minutes
Final setting time	>1and half an hour

Table 3.1.2: compressive strength

Grade of concrete	**M25 ; mix ratio 1:1.4:2.4**				
Specimen	Time	Trial			Mean value
		1	2	3	
Load on cube kn	28 days	700	750	1100	**25.03**
Compressive strength [N/mm^2]	28 days	26.1	28	21	

Table 3.1.3: Properties of fine aggregate:

Physical properties	Fine aggregate
Specific gravity	2.70
Fines modulus	2.74

Table 3.1.4: Properties of fine aggregate:

Physical properties	Coarse aggregates
Specific gravity	2.785
Fines modulus	7.38

3.2Parametric study

Shape configuration:

Table 3.2.1: shape configuration

Shape	Length [mm]	Breath [mm]	Depth[mm]
Rectangle welded wire reinforcement	1000	150	200
Rectangular with conventional reinforcement	1000	150	200
Square welded wire reinforcement	1000	250	250
Square with conventional reinforcement	1000	250	250

Varying stirrup spacing

Table 3.2.3: varying stirrup spacing

Shape	**Varying stirrup spacing**	**Welded wire reinforcement**		**Conventional reinforcement**	
		RW1	**RW2**		
Rectangle RW	150 c/c	4 - 12 ø	8 - 12 ø	———	
Rectangle RW	200 c/c	4 - 16 ø	4 - 12 ϕ and 4 - 16 ø		
Rectangle RC	150 c/c	———		**RC1**	**RC2**
				4 - 12 ø	8 - 12 ø
Rectangle RC	200 c/c			4 - 16 ø	4 - 12 ø and 4 -16 ø
Shape	**Varying stirrup spacing**	**SW1**	**SW2**	**SC1**	**SC2**
Square SW	200 c/c	4 - 12 ø	8 - 12 ø	———	
Square SW	250 c/c	4 - 16 ø	4 - 12 ø and 4 - 16 ø		
Square SC	200 c/c	———		4 - 12 ø	8 - 12 ø
Square SC	250 c/c			4 - 16 ø	4 - 12 ø and 4 - 16 ø

4.RESULTS AND DISCUSSIONS:

Loading arrangement: Sixteen columns were tested under axial compressive load. Columns were tested under loading frame of 1000 kN capacity. A gradual incremental load was applied by manually operated hydraulic jack. Strain values were measured from the strain gauge positioned at central height of column for various loads taken from the proving ring. The lateral deformations were measured by dial gauges of least count 0.01mm fixed at adjacent faces of the columns. Parameters such as initial cracking load, ultimate load and the deflected shape of the specimens were noted.

Figure 4.1 loading arrangement

Table 4: experimental results

Sl. no		Theoretical load(kN)	experimental load(kN)	Percentage difference %	Initial cracking(kN)	Initial		
						Deflection [mm]	Width [mm]	Length [mm]
1	Rw1 150 c/c	347	350	0.8	100	0.108	1	50
2	Rw1 200 c/c	347	400	1.15	129	0.047	1	65
3	Rc1 150 c/c	347	350	1.0	90	0.07	2	100
4	Rc2 200 c/c	347	420	1.21	100	0.041	1	75
5	Rw2 150 c/c	560	330	-69.9	110	0.072	2	70
6	Rw2 200 c/c	560	620	9.67	180	0.22	1	70
70.043	Rc2 150 c/c	560	400	-40	90	0.013	2	100
8	Rc2 200 c/c	560	240	-133	130	0.043	2	120
9	Sw1 200 c/c	658	840	21.6	210	0.118	1	40
10	Sw1 250 c/c	658	700	6	190	0.25	1	90
11	Sc1 200 c/c	658	700	6	250	0.37	2	47
12	Sc1 250 c/c	658	600	-9.6	170	0.023	2	50
13	Sw2 200 c/c	980	970	-1	200	0.112	2	100
14	Sw2 250 c/c	980	900	-8	320	0.149	2	90
150.03	Sc2 200 c/c	980	880	-11.3	190	0.038	2	100
16	Sc2 250 c/c	980	900	-8.8	200	0.108	2	100

Rectangular column with welded transverse reinforcement at 150 mm C/C

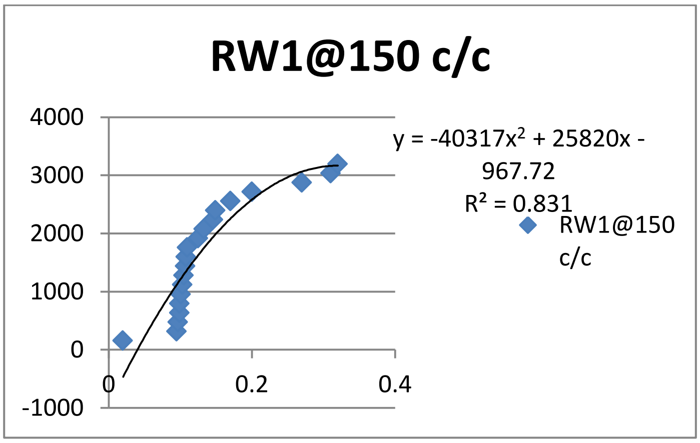

Figure 4.1 Figure 4.2

Figure 4.1 : Failure pattern of RW1%@150 mm c/c

Figure 4.2 : stress-strain graph for RW1%@150 mm c/c

The strain observed at initial stress is due to local crushing, then onwards the strain is proportional to the stress. The value of Young's modulus calculated through regression analysis is 25820. Initial crack observed at 100kN with 50mm length and 1mm width.

Rectangular column with conventional reinforcement at 150mm c/c

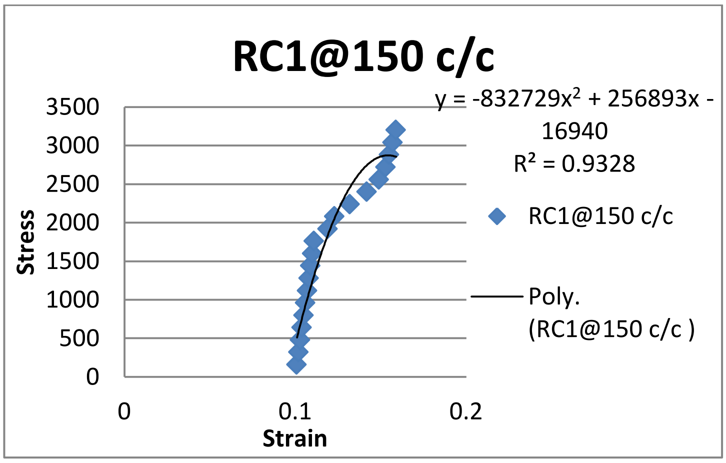

Figure 4.3 Figure 4.4

Figure 4.3: failure pattern RC1@150 mm c/c

Figure 4.4 : stress-strain graph RC1@150 mm c/c

The strain is proportional to the stress. The value of Young's modulus calculated through regression analysis is 256893. Initial crack observed at 47kN with 100mm in length and 2mm in width.

Square column with welded transverse reinforcement at 200mm c/c

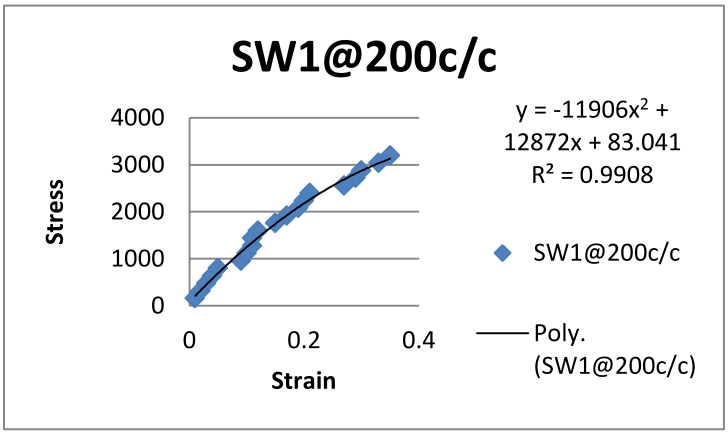

Figure 4.5 Figure 4.6

Figure 4.5: failure pattern SW1%@200 mm c/c

Figure 4.6 : stress-strain graph SW1%@200 mm c/c

The strain is proportional to the stress. The value of Young's modulus calculated through regression analysis is 12872. Initial crack observed at 210kN with 40mm in length and 1mm in width.

Square column with conventional reinforcement at 200mm c/c

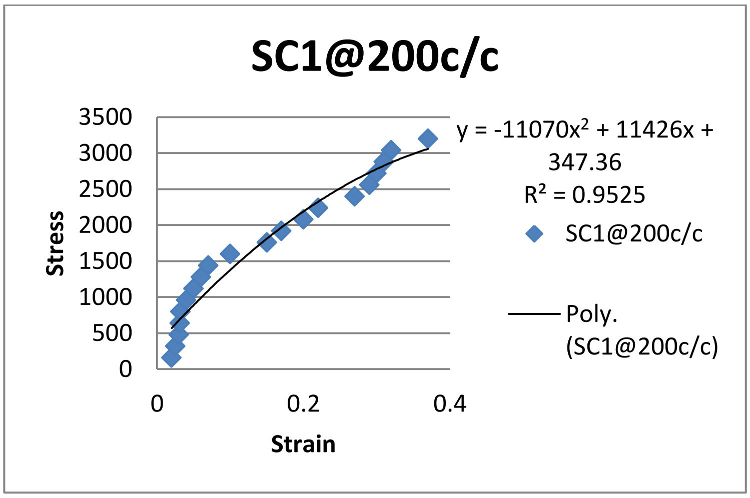

Figure 4.7 Figure:4.8

Figure 4.7: Failure patter for SC1%@200mm c/c

Figure4.8: stress- strain curve for SC1%@200 mm c/c

The strain is proportional to the stress. The value of Young's modulus calculated through regression analysis is 11426. Initial crack observed at 250kN with 60mm in length and 2mm in width.

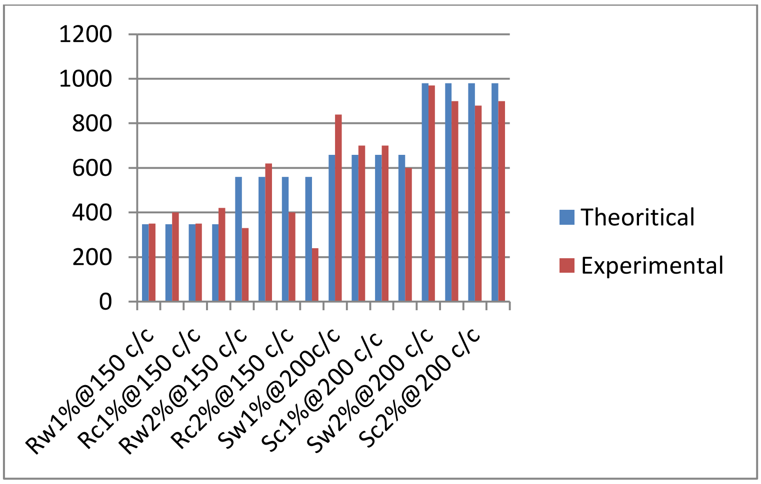

Figure 4.9: Comparison of theoretical and experimental loads

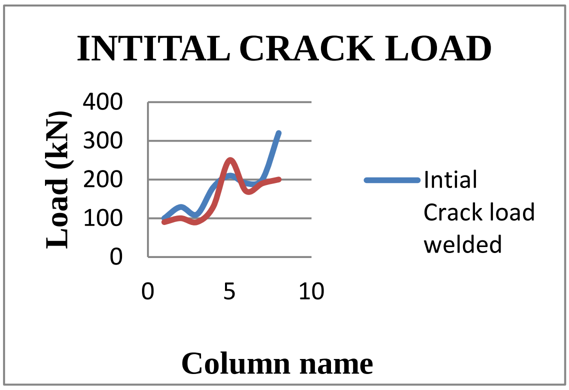

Figure 4.10: Initial crack load

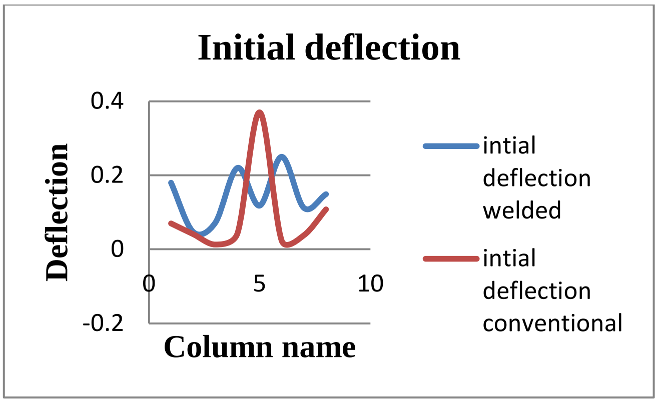

Figure 4.11: Initial deflection

5.LITERATURE REVIEW:

1. **B.Kusma, Tavio, and P.Suprobo (2015)**

"Behavior of concentrically loaded welded wire fabrics reinforced concrete column with varying reinforcement grids and ratios". The study includes variables such as lateral stirrup configuration the test results were increasing strength, ductility and toughness of the confined concrete core. Another parameter was confining volumetric ratio the test results were as the volumetric ratio was increasing the confining strength. And the other parameter as there is increase main reinforcement ratio would show effective performance in the increase in strength and this increment only for well-confined specimens with large ratio of WWR.

2. **Tavio and B.Kusuma (2015)**

"Analytical model for axial stress –strain behavior of welded reinforcement grids confined concrete column" A experimental investigation previously was done on the innovative method of applying welded reinforcement grids as transverse reinforcement. Under monotonic compression load was investigated now a stress strain model has been developed which includes confinement effect.

After analyzing the model there is an increase in strength and ductility for columns of 3x3 i.e., 9 cell columns compared to the columns of 2x2 i.e., 4 cell columns. And increase in ductility depends on confinement ratio.

SUMMARY

Welded wire reinforcement has potential application in earth-quake resistant structures. Experimental young's modulus determined by second order polynomial equation using curve fitting method is lesser than calculated theoretical young's modulus. Performance of rectangle welded wire reinforced columns with 1% steel has minimum deformation than conventional columns, whereas, with 2% steel has deformation greater than conventional columns similarly for square columns also.

Experimental ultimate load of SW1@200 c/c showed 21% increase over calculated theoretical ultimate load. Spacing of the lateral ties as mentioned in the Indian standard code is effective and enhanced performance in load carrying capacity. Welded wire reinforced rectangle as well as square columns has shown significant ductility characteristics.

REFERENCES

[1] B.Kusma, Tavio, and P.Suprobo (2015). Behavior of concentrically loaded welded wire fabrics reinforced concrete column with varying reinforcement grids and ratios.

[2] Tavio and B.Kusuma (2015). Analytical model for axial stress –strain behavior of welded reinforcement grids confined concrete column.

[3] K.S Babu naraynan et.al.(2009). Enhancement of Carrying Capacity and Ductility of

R.C.Columns with Welded Wire Fabrics as Lateral Reinforcements for Potential Application in Seismic Zones and Under Fire Load-An Experimental Investigation.

[4] Satjapan leelantanon and Trakool armaraks(2008).Behavior of short columns reinforced with welded wire Fabrics as transverse reiforcemnt under concentric loading.

[5] Swami W. Tabash (2007). Stress-strain model for high-strength concrete confined by welded wire fabrics.

[6] V.Viharika Reddy (2016). Comparative study on welded wire reinforced columns to conventional columns. M.Tech thesis work submitted to VTU Belgavi.